

CURRICULUM VITAE Michael Maclean Wolf

Sandia National Labs
Scalable Algorithms Department
P.O. Box 5800, MS 1320
Albuquerque, NM 87185-1320

mmwolf@sandia.gov (work)
mmwolf@gmail.com (home)
(505) 284-3391 (work)
<http://www.sandia.gov/~mmwolf/>

Research Interests

- High-performance computing, large-scale graph analytics, scientific computing, combinatorial algorithms.

Education

- Ph.D., Computer Science, University of Illinois at Urbana-Champaign, 2009.
Advisor: Professor Michael T. Heath.
- B.S., Computer Science and Biology, Harvey Mudd College, 1998.

Professional Experience

- **Technical Staff** (2014-present), Scalable Algorithms Dept., **Sandia National Laboratories**, Albuquerque, NM. Research into large-scale graph and data analytics, data partitioning algorithms, and exascale programming models.
- **Technical Staff** (2011-2014), Computing and Analytics Group, **MIT Lincoln Laboratory**, Lexington, MA. Responsibilities include research, leading software projects, developing software, interacting with program managers (e.g., DARPA), and program development. Leading team in the development of LLMORE software for data to processor mapping and simulation of key Department of Defense applications to existing and experimental computer architectures. Developing high-performance computing algorithms and software for solving very large graph problems.
- **Postdoc** (2009-2011), Scalable Algorithms Dept., **Sandia National Laboratories**, Albuquerque, NM, Staff Mentor: Karen Devine. **Extreme-scale Algorithms and Software Institute (EASI)**: developed architecture-aware algorithms for scalable performance. Developed multithreaded triangular solve algorithms and techniques for interfacing traditional MPI applications with hybrid MPI/multithreaded solvers. **Institute for Combinatorial Scientific Computing and Petascale Simulations (CSCAPES)**: researched and developed partitioning and ordering algorithms, including development of Zoltan2, a package for partitioning, load-balancing, etc. Led Sandia effort in sponsoring Harvey Mudd College clinic project on sparse matrix partitioning. **Other**: developed algorithms to improve performance of FV-MAS climate modeling software and for the GPU acceleration of a finite difference code for seismic modeling.
- **Graduate Research Assistant** (2007-2009), University of Illinois at Urbana-Champaign Computer Science Department, under the direction of Michael T. Heath.

- **Graduate Professional Intern** (Summers 2007, 2008), Computer Science Research Institute, **Sandia National Laboratories**, Albuquerque, NM, Staff Mentor: Erik Boman. Researched and developed two-dimensional matrix partitioning algorithms for reducing communication volume in parallel sparse matrix-vector multiplication as part of CSCAPES, a DOE SciDAC Institute. Implemented select partitioning algorithms in Isorropia, a load-balancing package in Trilinos.
- **DOE CSGF Intern** (Summer 2006), Computer Science Research Institute, **Sandia National Laboratories**, Albuquerque, NM, Staff Mentor: Karen Devine. Researched agent-based disease propagation models to be used in inverse problem of disease characterization from patient data. Researched combinatorial optimization problem of reducing the number of operations in matrix-vector multiplication.
- **DOE CSGF Intern** (Summer 2004), NERSC Scientific Computing Group, **Lawrence Berkeley National Laboratory**, Berkeley, CA, Staff Mentor: Ali Pinar. Researched and improved performance of parallel matrix-vector multiplication with scalar addition algorithm. Researched computational biology problems of protein folding.
- **Software Developer** (1998-2003), Advanced Computations Department, **Stanford Linear Accelerator Center**, Stanford, CA, Supervisor: Kwok Ko. Developed parallel electromagnetic solvers and particle tracking software used in accelerator design as part of DOE SciDAC and Grand Challenge projects. Improved parallel performance of applications with better partitioning and communication techniques. Managed software projects and mentored seven summer students. Involved in setting up Linux cluster.
- **Software Developer** (Summer/Winter Breaks 1996-1998), **MPI Software Technology, Inc.**, Starkville, MS. Software engineer and author of documentation. Responsibilities included writing documentation explaining how to use MPI, developing MPI-2 technology, and providing consultation on commercial MPI implementations.
- **HMC Clinic Team Leader** (1997-1998), HMC Computer Science Clinic, Claremont, CA Optivus Technology, Inc. Project. Led a team of four students in designing and developing a software tool for allowing accurate, automatic, and rapid registration of radiographic images. Responsibilities included project design, interaction with Optivus liaison, and writing image registration software.
- **Intern** (Summer 1996), NSF Research Experience for Undergraduates, Engineering Research Center, **Mississippi State University**, MS, Mentor: Anthony Skjellum. Researched object-oriented programming techniques. Learned how to write parallel programs using the Message Passing Interface (MPI). Implemented parallel conjugate gradient algorithm using C++ and the MPI library. Researched three approaches to object-oriented MPI programming: MPI-2 C++ bindings, MPI++, and OOMPI.

Journal Articles

- M.M. Wolf and M.T. Heath, "Combinatorial Optimization of Matrix-Vector Multiplication in Finite Element Assembly," *SIAM Journal on Scientific Computing*, Volume 31, Issue 4, 2009, pp. 2960-2980.

- A. Skjellum, D. Wooley, Z. Lu, M. Wolf, P. Bangalore, A. Lumsdaine, J. Squyres, B. McCandless, "Object-Oriented Analysis and Design of the Message Passing Interface," *Concurrency and Computation: Practice and Experience*, Volume 13, Issue 4, 2001, pp. 245-292.

Conference Proceedings

- Michael M. Wolf, H. Carter Edwards, and Stephen L. Olivier, "Kokkos/Qthreads Task-Parallel Approach to Linear Algebra Based Graph Analytics," *Proc. of 20th Annual IEEE High Performance Extreme Computing Conference*, 2016.
- Michael M. Wolf, Alicia M. Klinvex, and Daniel M. Dunlavy, "Advantages to Modeling Relational Data using Hypergraphs versus Graphs," *Proc. of 20th Annual IEEE High Performance Extreme Computing Conference*, 2016.
- Michael M. Wolf, Jonathan W. Berry, and Dylan T. Stark, "A Task-Based Linear Algebra Building Blocks Approach for Scalable Graph Analytics," *Proc. of 19th Annual IEEE High Performance Extreme Computing Conference*, 2015.
- Michael M. Wolf and Benjamin A. Miller, "Improving the performance of graph analysis through partitioning with sampling," *Proc. of 19th Annual IEEE High Performance Extreme Computing Conference*, 2015.
- Michael M. Wolf and Benjamin A. Miller, "Sparse Matrix Partitioning for Parallel Eigenanalysis of Large Static and Dynamic Graphs," *Proc. of 18th Annual IEEE High Performance Extreme Computing Conference*, 2014.
- Daniel Kimball, Elizabeth Michel, Paul Keltcher, and Michael M. Wolf, "Quantifying the Effect of Matrix Structure on Multithreaded Performance of the SpMV Kernel," *Proc. of 18th Annual IEEE High Performance Extreme Computing Conference*, 2014.
- Erik G. Boman and Michael M. Wolf, "A Nested Dissection Partitioning Method for Parallel Sparse Matrix-Vector Multiplication," *Proc. of 17th Annual IEEE High Performance Extreme Computing Conference*, 2013.
- Julie S. Mullen, Michael M. Wolf, and Anna Klein, "PAKCK: Performance and Power Analysis of Key Computational Kernels on CPUs and GPUs," *Proc. of 17th Annual IEEE High Performance Extreme Computing Conference*, 2013.
- D. Whelihan, J. Hughes, S. Sawyer, E. Robinson, M. Wolf, S. Mohindra, J. Mullen, A. Klein, M. Beard, N. Bliss, J. Chan, R. Hendry, K. Bergman, and L. Carloni, "P-sync: A Photonically Enabled Architecture for Efficient Non-local Data Access," 2013 IEEE 27th International Parallel and Distributed Processing Symposium (IPDPS), pp.189-200.
- Michael M. Wolf, et al., "LLMORE: A Framework for Data Mapping and Architecture Analysis," *Proc. of 16th Annual IEEE High Performance Extreme Computing Conference*, 2012.
- Michael M. Wolf, Michael A. Heroux, and Erik G. Boman, "Factors Impacting Performance of Multithreaded Sparse Triangular Solve," High Performance Computing for Computational Science: VECPAR 2010, Berkeley, CA, June 22-25, 2010.
- E.G. Boman, U.V. Catalyurek, C. Chevalier, K.D. Devine, I. Safro, and M.M. Wolf. "Advances in Parallel Partitioning, Load Balancing, and Matrix Ordering," *J. of Physics: Conference Series*, vol. 180, 012008. (SciDAC09 Conference, San Diego, June 2009.)
- M.M. Wolf, E.G. Boman and B. Hendrickson, "Optimizing Parallel Sparse Matrix-Vector Multiplication by Corner Partitioning," PARA08, Trondheim, Norway, May 2008.
- M. Wolf, A. Guetz and C.-K. Ng, "Modeling Large Accelerator Structures with the Parallel Field Solver Tau3P," *18th Annual Review of Progress in Applied Computational Electromagnetics: ACES 2002*.

- V. Ivanov, C Adolphsen, N. Folwell, L. Ge, A. Guetz, Z. Li, C.-K. Ng, J.W. Wang, M. Wolf, K. Ko, G. Schussman, M. Weiner, "Simulating Accelerator Structure Operation at High Power," *Proceedings of the 2003 Particle Accelerator Conference*, 2003, pp. 2664-2666.
- N. Folwell, L. Ge, V. Ivanov, Z. Li, C.-K. Ng, G. Schussman, M. Weiner, M. Wolf, and K. Ko, "Numerical Studies of Field Gradients and Dark Currents in SLAC Structures," *Proceedings of the International Computational Accelerator Physics Conference*, 2002.
- L.-Q. Lee, L. Ge, M. Kowalski, Z. Li, C.-K. Ng, G. Schussman, M. Wolf, K. Ko, "Solving Large Sparse Linear Systems in End-to-end Accelerator Structure Simulations," *Proceedings of 18th International Parallel and Distributed Processing Symposium*, 2004.
- Z. Li, N. Folwell, L. Ge, A. Guetz, V. Ivanov, M. Kowalski, L. Lee, C. Ng, G. Schussman, R. Uplenchwar, M. Wolf, and K. Ko, "X-band Linear Collider R&D in Accelerating Structures through Advanced Computing," *Proceedings of 9th European Particle Accelerator Conference*, 2004.

Presentations

- "Kokkos/Qtreads Task-Parallel Approach to Linear Algebra Based Graph Analytics," IEEE HPEC 2016, Waltham, MA, September 2016. (Refereed)
- "Task Parallel Approach to the Linear Algebra-Based Implementation of miniTri," SIAM Annual Meeting (AN16), Boston, MA, July 11-15, 2016. (Minisymposium Presentation.)
- "Hypergraph Exploitation for Data Sciences," Graph Exploitation Symposium, Dedham, MA, May 18-19, 2016. (Invited Talk.)
- "A Task-Based Linear Algebra Building Blocks Approach for Scalable Graph Analytics," IEEE HPEC 2015, Waltham, MA, September 2015. (Refereed)
- "Zoltan2 for Extreme-Scale Data Partitioning: Sampling and Partitioning," SIAM Conference on Computational Science and Engineering (CSE15), Salt Lake City, UT, March 14-19, 2015. (Minisymposium Presentation.)
- "Sparse Matrix Partitioning for Parallel Eigenanalysis of Large Static and Dynamic Graphs," IEEE HPEC 2014, Waltham, MA, September 2014. (Refereed)
- "Detecting Anomalies in Very Large Graphs," The Sixth SIAM Workshop on Combinatorial Scientific Computing (CSC14), Lyon, France, July 21-23, 2014. (Refereed)
- "Effective Parallel Computation of Eigenpairs to Detect Anomalies in Very Large Graphs," SIAM Conference on Parallel Processing for Scientific Computing (PP14), Portland, OR, February 18-21, 2014. (Contributed Presentation.)
- "A Nested Dissection Partitioning Method for Parallel Sparse Matrix-Vector Multiplication," IEEE HPEC 2013, Waltham, MA, September 2013. (Refereed)
- "LLMORE: A Framework for Data Mapping and Architecture Analysis," IEEE HPEC 2012, Waltham, MA, September 2012. (Refereed)
- "Obtaining Parallelism on Multicore and GPU Architectures in a Painless Manner," 2010 SEG Post-Convention Workshop on High Performance Implementation of Geophysical Applications, Denver, October 21, 2010. (Invited Talk)
- "Factors Impacting Performance of Multithreaded Sparse Triangular Solve," High Performance Computing for Computational Science: VECPAR 2010, Berkeley, CA, June 22-25, 2010. (Refereed)
- "Recent Advances in Two-dimensional Sparse Matrix Partitioning," SIAM Conference on Parallel Processing for Scientific Computing (PP10), Seattle, WA, February 24-26, 2010. (Minisymposium presentation.)

- “Improved Data Partitioning by Nested Dissection with Applications to Information Retrieval,” SIAM Workshop on Combinatorial Scientific Computing (CSC09), Seaside, CA, October 29-31, 2009. (Refereed presentation).
- “Hypergraph-Based Combinatorial Optimization of Matrix-Vector Multiplication,” 2008 SIAM Annual Meeting, San Diego, CA, July 7-11, 2008. (Minisymposium Talk.)
- “Optimizing Parallel Sparse Matrix-Vector Multiplication by Partitioning,” 2008 CSCAPES Workshop, Santa Fe, NM, June 10-13, 2008. (Invited Talk.)
- “Nested Dissection Approach for Sparse Matrix Partitioning,” SIAM Conference on Parallel Processing for Scientific Computing, Atlanta, GA, 2008. (Contributed Talk.)
- “Combinatorial Optimization of Matrix-Vector Multiplication,” SciDAC 2007 Conference, Boston, MA. (Poster Presentation.)
- “Using Parallel Mesh Partitioning Strategies to Improve the Performance of Tau3P, an Electromagnetic Solver,” SIAM Conference on Parallel Processing for Scientific Computing, San Francisco, CA, 2004. (Contributed Talk.)
- “Modeling Large Accelerator Structures with the Parallel Field Solver Tau3P,” 18th Annual Review of Progress in Applied Computational Electromagnetics, Monterey, CA, 2002. (Contributed Talk.)

Technical Reports, Extended Abstracts, Posters, and Other Papers

- “Effects of Graph Structure on 2D Partitioning of Scale-Free Graphs with Sampling,” SIAM Workshop on Network Science 2015, Snowbird, UT, May 2015. (Peer reviewed poster)
- Michael M. Wolf and Ben A. Miller, “Detecting Anomalies in Very Large Graphs,” The Sixth SIAM Workshop on Combinatorial Scientific Computing (CSC14), Lyon, France, July 21-23, 2014. (Peer reviewed extended abstract)
- Michael M. Wolf, Michael A. Heroux, and Erik G. Boman, “Hybrid MPI/Multithreaded PCG: A Use Case for MPI Shared Memory Allocation,” Supercomputing 2010, New Orleans, November 13-19, 2010. (Peer reviewed poster)
- M. Wolf and E. Boman, “An Increasing Role for Combinatorial Methods in Large-Scale Parallel Simulations,” *SIAM News*, Volume 41, Number 5, June 2008.
- M. Wolf and E. Boman, “Partitioning for Parallel Sparse Matrix-Vector Multiplication,” SANDIA Technical Report SAND2007-7977, Sandia National Laboratories, 2007, pp. 75–86.
- J. Ray, B. M. Adams, K. D. Devine, Y. M. Marzouk, M. M. Wolf, and H. N. Najm, “Distributed Micro-Releases of Bioterror Pathogens: Threat Characterizations and Epidemiology from Uncertain Patient Observables,” SANDIA Technical Report SAND2008-6044, Sandia National Laboratories, 2008.
- “Tau3P: A Parallel Time-Domain Solver for the DOE Grand Challenge,” International Computational Accelerator Physics Conference, Monterey, CA, 2002. (Poster)

Honors, Awards, and Travel Grants

- **Department of Energy Computational Science Graduate Fellowship (CSGF), 2003-2007.**
- **IEEE HPEC Best Paper Finalist, 2015.**
- **University of Illinois Fellowship, 2007-2008.**
- **SIAM Student Chapter Certificate of Recognition as UIUC Student Chapter President, 2008.**

- SIAM Travel Award, Conference on Parallel Processing for Scientific Computing, 2008.
- Co-author of Best Poster, International Computational Accelerator Physics Conference, 1998.
- Dean's List, Harvey Mudd College, 1995-98 (all semesters).

Service

- **Sandia/NM Practicum Coordinator** for Department of Energy (DOE) CSGF (2015-present).
- DOE CSGF **Selection Committee** (2015-present).
- IEEE HPEC Conference Technical Committee (2015-).
- DOE CSGF **Applications Screening Committee**.
- Reviewer for Department of Energy
- SIAM CSC 2016 Local Organizing Committee.
- **Liaison**, SNL sponsored Harvey Mudd College Computer Science Clinic (2010-2011).
- **Organizer**, Gene Golub Symposium at UIUC, Urbana, Illinois, February 29 - March 1, 2008.
- **Co-organizer**, Combinatorial Scientific Computing Minisymposium, 2008 SIAM Annual Meeting, July 7-11, 2008.
- **SIAM UIUC Student Chapter President**, 2007-2009.
- SIAM UIUC Student Chapter Vice-President, 2006-2007.
- Reviewer for Department of Energy.
- Reviewer for *Transactions on Mathematical Software*.
- Reviewer for *Applied Mathematics and Computation*.
- Reviewer for *International Journal of High Performance Computing*.
- UIUC CS Fellowship, Assistantship, and Admissions Committee, 2008-present.
- UIUC Computer Science Undergraduate Studies Committee, 2006-2007.

Computer Skills

- Languages: C++, C, R, Perl, Fortran, Matlab, Python, Java, Lex, Yacc, et al.
- Systems: UNIX (MacOS X, Linux, Solaris, etc.), MS-Windows.
- Libraries: MPI, OpenMP, Pthreads, Intel TBB, HPX, Zoltan, Trilinos, ParMETIS, PETSc, BLAS, SuperLU, et al.